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THE FIRST MAP OF THE FAR SIDE OF THE MOON

(Pervaya karta obratnoy storony luny)

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During all the time of the Earth's existence, human eye could not have perceived the far side of the Moon. It is quite probable that the original Moon had an axial rotation relatively to the Earth, bu this rotation was so much slowed down on account of tidal friction, that the Moon remained forever with one side turned toward the Earth.

However, because of the optical and parallactic libration of the Moon only 59% of its surface may be observed from the Earth, although its edges are visible strongly fore-shortened.

It thus appeared, hardly several years ago, that the remaining 41 percent of lunar surface would remain forever inaccessible to observations. This opinion was sharply reversed after the interplanetary rocket, launched in January 1959 in the USSR, passed near the Moon and became an artificial satellite of the solar system. Thus was demonstrated the possibility of reaching a point from which the far side of the Moon would be visible, but there remained the problem of obtaining a photograph of that side, and transmitting it to the Earth.

This problem was solved on 4 October 1959 when the third interplanetary rocket was launched in the USSR. Its last stage has put in orbit an automatic interplanetary station having aboard an automatic photocamera, provided with two objectives (20 and 50 cm focal distance), and loaded with a 35 mm film. The optical axes of both objectives were parallel. A special orientation system, including

optical and gyroscopic transmitters, logical electronic devices and guidance systems, assured their direction toward the Moon during the whole photographing. The rocket's orbit had a great inclination toward the ecliptic, and the apogee distance, after accounting the great perturbations near the Moon, was 400.00 km. On October 7, at 0700 hours Moscow Time the automatic station was situated at a distance of 65,000 km from the Moon, near the straight line linking the Moon to the Sun. The age of the Moon for the Earth was then only 4.6 days, but for the automatic station it was nearly full Moon.

At that time, and on command from the Earth, the Moon-directed objectives began exposing the film in turns. This film was then automatically revealed in the container, fixed and dryed. The working out has been realized by a special small installation ensuring the normal course for all processes in conditions of weigthlessness.

A series of photographs were obtained by both objectives during 40 minutes. After several days, when the automatic stations was sufficiently close to the Earth, the images of the negatives were transmitted to the various USSR receiving stations with the aid of television. This was done by scanning the negatives by means of bright point moving through the images, the number of lines reaching one thousand. The scanning took place at two different speeds: the slowest at greater distances from the Earth, and the fastest when the station was nearer.

Because of the station's rotation, radio waves must have been emitted in all directions, and this resulted in a considerable drop in received signals' intensity, these being several million times weaker than in standard television. The best obtained negatives were those photographed by the short-focus camera (numbers 27, 29, 31 and 35), and numbers 26, 28, 32, 34 and 36 obtained by long-focus camera. On the first series, the Moon's image had a 10.4 mm diameter, and it fitted entirely

within the frame. On long-focus photos the diameter was about 26 mm, and part of the Moon remains outside the frame.

During the photographing the automatic stations had the following selenographic coordinates: latitude +17°, longitude 117°. They are also the coordinates of the center of the pictures of the Moon on negatives. The part of the Moon's surface visible from the Earth was also fixed on the photographs. This is extremely valuable for control during the deciphering of the photographs, as it allows the establishment of a reliable connection between the visible and the far side of the Moon. Such parts and formations on the known side of the Moon as Mare Crisium (Sea of Crises), Mare Humboltianum (Humbolt's Sea), Mare Marginis (Border Sea), Mare Smythii, Mare Australe (Southern Sea) are well visible. The last three pass the boundary between visible and the far side, and reach deeply into the latter.

The original negatives transmitted from the interplanetary station were reproduced in three copies, and magnified prints were obtained from them. These materials were sent to three scientific institutions: The Astronomical Observatory of the Khar'kov University, The Main Astronomical Observatory of the USSR Academy of Sciences in Pulkovo, and the State Astronomical Institute in the name of P. K. Shternberg in Moscow. An independent study of the photographs was performed in each of these scientific centers, and the results were compared. The most exhaustive investigation was performed in Moscow, in cooperation with the Central Institute of Scientific Research in the Fields of Geodesy, Cartography and Aerial Photography.

The deciphering started with the transformation of pictures in such a manner that the edge of the Moon transformed itself into an exact circle, account being taken of a certain loss near the North Pole of the Moon unlit by the Sun. Several methods were tested in order to eliminate television transmission interferences, including the juxtaposition of several photographic frames. However, the best

method was the one consisting in the preparation of several photometric cuts from each frame for various density values.

This could be realized by using the photograph and radiophysical technique. Two nearby density levels were selected, and the part of the picture included between them was reinforced by contrast several times, while the picture details outside this interval were eliminated as being plain white or black spots. The detailed comparative study of various frames allowed the separation of those details which were real, and their differentiation from the imaginary ones provoked by television transmission interferences. The selenographic coordinates of the details were determined, and every detail revealed was described and recorded in the general catalogue, entering the Atlas of the Far Side of the Moon edited by the USSR Academy of Sciences. The catalogue was divided in three sections by order of authenticity. The first section included the formations revealed by not less than three different frames, or those so sharply discernable, that no doubts could be raised about their authenticity. There were 252 such formations, of which about 100 are located on the visible part of the Moon, and this provides a complementary verification of the deciphering accuracy. 190 less clear formation, obtained only on two frames, are described in the second part of the catalogue. The third and the last part of the catalogue contains 57 formations, visible only on one frame, or having vague contours. All these formations are plotted on the map of the Moon assembled in the equatorial orthographic projection, and the objec ts of the three sections are indicated by different conventional signs.

It must be noted, that the far side of the Moon notably differs from the visible side by the scarcity of seas. This cannot be ascribed to image shortcomings since all such seas visible from the Earth as the Sea of Crises, the Border Sea, and others, are quite apparent in the frames. There is on the far side of the Moon

only one clearly outlined sea between 23 and 32 deg.Northern latitude, and 145 to 152° longitude. The other shaded region of the southern hemisphere near the edge of the pictures apparently is an extended sea,but it is not easy to distinguish from the general darkening at edges. The major part of the far side is lighter than the usual surface of the seas, and it resembles the mountainous regions of the visible side. It is probable that most of the indicated spots represent craters and ring-shped mountains, some of which having central peaks. It is curious that the prediction by the German professor observer Yu.Franz, who wrote in 1906 in the book "THE MOON": "... we conclude that there lies on the far side of the Moon an extended clear, crater-rich elevation on the side of the North sea edge.." came true. Various guesses on the causes of such difference between the visible and the far side of the Moon were also stated. They have been ascribed to the influence of the Earth, and namely by solar eclipses on the Moon which it provokes, to the terrestrial gravitational attraction, by the defense or shieding the Earth provides to the visible side of the Moon from meteorites. However, the differences revealed cannot be explained by these influences.

First of all, solar eclipses exist only on the visible side of the Moon. During their occurrence, the temperature of the lunar surface suddenly drops by nearly 200 degrees from about +100°, and then rises again to the original level in a very short time. Inasmuch as the heat conductivity of the outer layers of the Moon is, as is known, very small, this temperature variation does not penetrate deeper than several centimeters. Therefore it is impossible that it may induce general changes in the structure of its far side.

Then there is the gravitational attraction of the Earth. It is revealed in a tidal action which is nearly symmetrical on both sides of the Moon.

It is easy to calculate that the influence on the visible side of the Moon is only 0.5 percent stronger than on the far side. The difference between the two tidal assaults would only have been greater, if in the remote past, the Moon had been closer to the Earth than at the present time.

As to the shielding action of the Earth in relation to meteorites, this action is very small, as the Earth's disc in the sky, as seen from the Moon, only occupies 1/7300th part of the hemisphere. Moreover, it should be pointed out that the Earth's attraction compels the flying nearby meteorites to curve their path, as if it focused them inside the Earth's "shadow". The computations of one of our scientists have shown that meteorites, flying at usual relative velocities, have focal points considerably nearer than the Moon. The focus is situated at the distance of the Moon only for meteorites with relative velocities near 70 km/sec, but such meteorites are very scarce, and they could, in the extreme, only compensate the shielding action of the Earth.

Therefore, outside causes explaining the differences between the two sides of the Moon are lacking. We estimate that there is no need to search for such a cause, since, by way of analogy, there is no cause of the dyssymetry of the Earth's surface. Let us take the Eastern and the Western hemispheres of the Earth, which are situated relatively to the Sun, to the Moon, and to other heavenly bodies in an entirely identical position owing to the daily rotation of the Earth, and there is, nonetheless, a sharp difference in the surface of continents and oceans. This obviously is explained by inner causes, and such is in all probability the origin in the difference of structure of the two hemispheres of the Moon.

Let us add a few words concerning the denomination of details revealed on the far side of the Moon. It is the privilege of the discoverer to confer appellations on newly discovered formations of the solar system, for instance small

planets. On the visible side of the Moon mountains and craters are designated by the names of scientists, and the mountain ranges - by their terrestrial analogues. It seemed to us that this tradition should be preserved for the formations discovered on the far side of the Moon. However, in the given case, there are several discoverers. That is why the USSR Academy of Sciences has appointed a small commission, whose terms of reference consist in confering names to new formations. So far. nearly 20 of the most prominent objects of the far side of the Moon were called by names of prominent scientists and figures of all times and nationalities.

The Atlas of the Far Side of the Moon, assembled according to materials obtained with the aid of the third Soviet interplanetary rocket, marks the beginning of a new era in the study of cosmic object: the transfer of the observation station to any selected point of the solar system, from which it is possible to observe and investigate those phenomena which will remain for centuries concealed and inaccessible to ground observers.

Translated by Andre L. Brichant
NASA TECHNICAL INFORMTION DIVISION
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N.B. The plate attached is reproduced as it is in the original. The English version of it, prepared by the USSR Academy of Sciences is now available through OTS of the Commerce Department, and the Air Force. (OTS order 61-21955) cost: $3.)